PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04N

A2

(11) International Publication Number: WO 97/47128

(43) International Publication Date: 11 December 1997 (11.12.97)

(21) International Application Number: PCT/GB97/01486

(22) International Filing Date: 2 June 1997 (02.06.97)

(30) Priority Data:
9611511.8 3 June 1996 (03.06.96) GB

(71) Applicant (*for all designated States except US*): NDS LIMITED [GB/GB]; 1 Heathrow Boulevard, 286 Bath Road, West Drayton, Middlesex UB7 0DQ (GB).

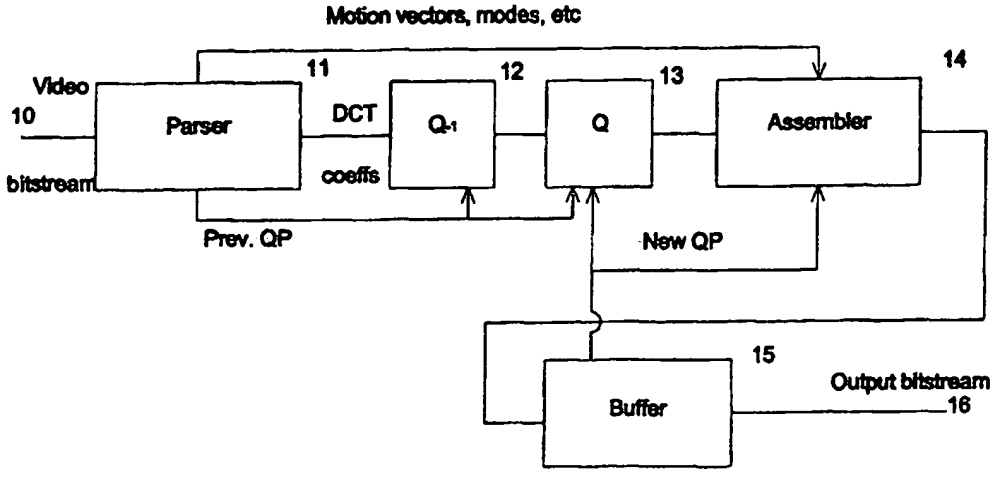
(72) Inventor; and
(75) Inventor/Applicant (*for US only*): BOCK, Alois, Martin [DE/GB]; 61 Haddon Drive, Boyatt Wood, Eastleigh, Hampshire SO50 4PF (GB).

(74) Common Representative: NDS LIMITED; Anderson, Angela, Mary, Stoneham Rectory, Stoneham Lane, Eastleigh, Hampshire SO50 9NW (GB).

(81) Designated States: JP, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: IMPROVEMENTS IN OR RELATING TO CHANGING THE BIT RATE OF A SIGNAL



(57) Abstract

The present invention relates to a method and apparatus for changing the bit rate of an input compressed digital signal such as a digitally compressed video signal including quantised picture information and motion vectors relating to motion compensation between picture frames. In order to change the bit rate of the signal, the present invention provides in a first step, for a partial decoding of the signal including a separation of a component including the motion vectors. In a second step, the quantisation of the quantised picture information is modified so as to change the compression of the picture information. In a third step, the modified picture information is reassembled with the motion vectors to generate an output video signal. The invention may be applied to a near video on demand (NVOD) in which the signal is multiplexed with time shifted versions of itself and the bit rate of the signal is changed such that the combined bit rate of the multiplexed signals is limited to a rate which can be accommodated by the multiplexer.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

IMPROVEMENTS IN OR RELATING TO CHANGING THE BIT-RATE OF A SIGNAL

The present invention relates to a method and apparatus for changing the bit rate of a digital video signal.

The digital signal may have been compressed using a compression algorithm employing quantisation method. If the digital signal is a digital video signal the quantisation may comprise quantisation of picture information and motion vectors relating to motion compensation between picture frames. For other types of signal the compression and quantisation techniques will be appropriate to the type of signal.

One method of changing the bit rate of a digitally compressed video signal, such as a video signal conforming to the well-known MPEG standards, would be to completely decode and re-code the signal using different parameters. The decoding step will recover the picture information and the re-coding step is applied using different quantisation parameters on the discrete cosine transform (DCT) coefficients.

It is however desirable to use a method of changing the bit rate of a digitally compressed video signal which avoids the necessity of subjecting the signal to complete decoding and re-coding. This is due to the fact that information may be lost if repetitive decoding and re-coding is carried out.

According to a first aspect of the present invention there is provided a method of changing the bit rate of a compressed input digital signal which includes first and second components of coded information, the first and second components being encoded differently from one another, the method comprising; subjecting the input digital signal to at least a partial decoding process including separating out the second component; modifying the compression of the first component; and reassembling the so modified first component with the second component to generate an output digital signal.

According to a second aspect of the invention there is provided a method of changing the bit rate of a compressed input digital video signal which includes a first component which comprises quantised picture information and a second component which comprises motion vectors relating to motion compensation between picture frames, the method comprising the steps of ; subjecting the input video signal to at least a partial decoding process including separating out the second component comprising the motion vectors; modifying the compression of the first component by modifying the quantisation of at least some of the quantised picture information; and reassembling the so modified picture information with the motion vectors to generate an output video signal including the modified picture information.

Further, according to the present invention there is provided apparatus for changing the bit rate of a compressed input digital video signal which includes a first component which comprises quantised picture information and a second component which comprises motion vectors relating to motion compensation between picture frames, the apparatus comprising; decoding means to subject the input video signal to at least a partial decoding process including separating out the component including the motion vectors; means to modify the compression of the first component by modifying the quantisation of at least some of the quantised picture information; and means to reassemble the so modified picture information with the motion vectors to generate an output video signal including the modified picture information.

The invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 shows a block diagram of a first system embodying the invention for modifying the bit rate of a video signal;

Figure 2 shows a second system, embodying the invention, for modifying the bit rate of a video signal; and

Figure 3 shows a third system, embodying the invention, for modifying the bit rate of a video signal.

In Figure 1 an input terminal 10 receives an input digital video signal and supplies the input signal to a parser 11. The incoming video signal is compressed using a standard MPEG compressed algorithm and includes a continuous series of coded frames including intra-coded (I) frames, forward prediction (P) frames and bi-directional prediction (B) frames. The video signal also includes motion vectors which relate to motion compensation between picture frames and mode information as is well known in the art. The compression algorithm is based on discrete cosine transformation (DCT) to convert the parser values in the data blocks from the time domain to the frequency domain together with quantisation of each frequency component by a quantisation parameter (QP).

In the parser 11, the incoming video signal is partially decoded to separate out the DCT coefficients which are inverse quantised in the block 12 using the transmitted previous quantisation parameter QP. The re-quantised output from the block 13 is passed to an assembler 14 and thence through a buffer 15 to an output terminal 16 from which the output bit stream is supplied by the apparatus of Figure 1.

The re-quantisation of the I and P frames in the block 13 is effected using the previous quantisation parameter as supplied by the parser 11. Consequently there is no change in bit rate for these frames.

The re-quantisation of the B frames is effected using a new quantisation parameter supplied to the block 13 and to the assembler 14 under the control of the buffer 15. The new quantisation parameter is used to effect a quantisation which is higher than the previous quantisation and is thereby effective to reduce the bit rate of the B frames and hence of the video signal.

The parser 11 separates out the motion vectors and mode information from the DCT coefficients and supplies them to the assembler 14 where they are assembled

with the re-quantised DCT coefficients to produce the bit stream to be supplied to the buffer 15.

Referring now to Figure 2, an input video bit stream is applied to an input terminal 20. The input video bit stream is of the same form as the bit stream applied to the input terminal 10 of Figure 1. A video decoder 21 receives and decodes the bit stream from the input terminal 20 and supplies the decoded signal to a block 22 which subjects the decoded signal to discrete cosine transformation. The output from the block 22 is applied to a block 23 where the DCT coefficients are subject to quantisation before supply to an assembler 24 where the coefficients are assembled with the motion vectors and mode information supplied by the decoder 21.

The assembled video signal is supplied through a buffer 25 to an output terminal 26. The quantisation effected by the block 23 is applied to all the DCT coefficients supplied by the block 22 so that a new quantisation parameter and therefore new bit rate is applied to all the picture frames.

An inverse quantisation block 27 and inverse DCT transformation block 28 supply picture information to a motion compensation block 29 which effects motion compensation employing the motion vectors from the video decoder 21. A mode block 30 controls the encoding mode as a result of inputs from the decoder 21, the motion compensation block 29 and the block 28. The encoding loop acts as a slave encoder in so far as it follows all mode decisions and motion vectors as dictated by the incoming video bit stream. Extracting motion information, in particular, is important in order to avoid the need for a costly motion estimator in the encoding loop.

The essential difference between the system of Figure 2 and the system of Figure 1 is that in the system of Figure 2, all the DCT coefficients are re-quantised, not just those for the B frames. This increases the scope for changing the data rate substantially but is achieved at the expense of using a complete predictive encoding loop.

It will be appreciated that the above method and apparatus could equally be used on signals other than digital video signals. The invention could apply to any digital signal which includes two or more different types of information which each have different coding requirements. By re-coding only those parts of the signal which can be easily decoded and re-coded processing power is not wasted when steps are being taken to modify the bit rate of a signal.

This invention will be a useful addition to so-called statistical multiplexing systems such as those described in our co-pending applications GB9517130.2 and GB9607162.6.

The benefit of statistical multiplexing has been demonstrated even for a relatively small number of multiplexed video bit streams. In a near video on demand (NVOD) service the same file of recorded compressed video information is played out many times in parallel with time-shifted versions of itself to provide multiplexed video bit streams. The combined bit rate of the time shifted video bit streams may overload the output multiplexer used to multiplex the bit streams, i.e. a given combined bit rate would be exceeded. By transcoding only those parts of the bit stream which lead to potential overload, the invention provides a way of generating a new bit stream which has a bit rate changed so that the total allocated bit rate is not exceeded and the available bandwidth is therefore used more efficiently.

Referring now to Figure 3, a recorder 31 is employed to record the video bit stream for a NVOD service with a variable bit rate and a quantisation parameter of 9. The recorded bit stream is available to a multiplexer 32 from which the multiplexed NVOD bit stream is supplied to an output terminal 33. A bit rate profile of the recorded bit stream is derived by calculation in the calculating means 34. The time periods where the combined bit rate will exceed the total bit rate capacity of the multiplexer 32 are identified by the calculating means 34. The video bit stream is supplied to the system 35 which modifies the bit rate of the video bit stream under the control of the calculating means 34 and the modified bit stream is returned to be re-recorded in the recorder 31.

The system 35 to modify the bit rate of the bit stream is as shown in Figure 1 with a modification to derive the new quantisation parameter from the calculating means 34 instead of the buffer 15. The new quantisation parameter, which may for example be 11, is applied to re-code the B frames of the bit stream in the time periods identified by the calculating means so that the required quantisation parameter for the combined bit rate is obtained. While the effect of increasing the quantisation of the B frames from 9 to 11 is quite small in relation to one bit stream, the overall effect is sufficient to limit the combined bit rate to meet the capacity of the multiplexer 32 if the number of streams is large enough.

CLAIMS

1. A method of changing the bit rate of a compressed input digital signal which includes first and second components of coded information, the first and second components being encoded differently from one another, the method comprising; subjecting the input digital signal to at least a partial decoding process including separating out the second component; modifying the compression of the first component; and reassembling the so modified first component with the second component to generate an output digital signal.

2. A method of changing the bit rate of a compressed input digital video signal which includes a first component which comprises quantised picture information and a second component which comprises motion vectors relating to motion compensation between picture frames, the method comprising the steps of ; subjecting the input video signal to at least a partial decoding process including separating out the second component comprising the motion vectors; modifying the compression of the first component by modifying the quantisation of at least some of the quantised picture information; and reassembling the so modified picture information with the motion vectors to generate an output video signal including the modified picture information.

3. A method according to claim 1 or 2, including a further step of recording the output digital signal.

4. A method as claimed in claim 3, comprising the further steps of reproducing the recorded output digital signal with time-shifted versions of itself and multiplexing the time-shifted versions of the output digital signal.

5. A method as claimed in claim 4, comprising the further steps of calculating the combined bit rate of the multiplexed versions of the output digital signal

and indicating when the said combined bit rate exceeds a predetermined limit.

6. A method as claimed in claim 5, wherein the step of modifying the compression of the said first component of the input digital signal limits the said combined bit rate to the said predetermined limit.

7. A method as claimed in any one of the preceding claims wherein the first component of the input digital signal comprises a continuous series of coded picture frames and the second component of the input digital signal comprises motion vectors which relate to motion compensation between the picture frames.

8. A method as claimed in claim 7, wherein the input digital signal includes intra-coded (I) picture frames, forward prediction (P) picture frames, bi-directional (B) picture frames and a transmitted quantisation parameter, the method including the steps of inverse quantising the I, P and B frames, re-quantising the I and P frames with the transmitted quantisation parameter and re-quantising the B frames with a different quantisation parameter.

9. A method as claimed in claim 7, wherein the input digital signal includes intra-coded (I) picture frames, forward prediction (P) picture frames, bi-directional (B) picture frames and a transmitted quantisation parameter, the method including the steps of inverse quantising the I, P and B frames, and re-quantising the I, P and B frames with a quantisation parameter which is different from the transmitted quantisation parameter.

10. Apparatus for changing the bit rate of a compressed input digital signal which includes first and second components of coded information, the first and second components being encoded differently from one another, the apparatus comprising; decoding means to receive and subject the input signal to at least a partial decoding process including separating out the second component; means to modify the compression of the first

component; and means to reassemble the so modified first component with the second component to generate an output digital signal.

11. Apparatus for changing the bit rate of a compressed input digital video signal which includes a first component which comprises quantised picture information and a second component which comprises motion vectors relating to motion compensation between picture frames, the apparatus comprising; decoding means to subject the input video signal to at least a partial decoding process including separating out the component including the motion vectors; means to modify the compression of the first component by modifying the quantisation of at least some of the quantised picture information; and means to reassemble the so modified picture information with the motion vectors to generate an output video signal including the modified picture information.

12. Apparatus as claimed in claim 10 or 11, further comprising means to record the output digital signal.

13. Apparatus as claimed in claim 12, further comprising means to reproduce the output digital signal with time-shifted versions of itself and a multiplexer to multiplex the time-shifted versions of the output digital signal.

14. Apparatus as claimed in claim 13, further comprising calculation means to calculate the combined bit rate of the multiplexed versions of the output digital signal and to indicate when the said combined bit rate exceeds a predetermined limit.

15. Apparatus as claimed in claim 14, wherein the means to modify the compression of the said first component of the input digital signal is operable to limit the said combined bit rate to the said predetermined limit.

16. Apparatus as claimed in any one of claims 10 to 15, which is adapted to change the bit rate of a compressed input digital signal in which the first

component of the input digital signal comprises a continuous series of coded picture frames and the second component of the input digital signal comprises motion vectors which relate to motion compensation between the picture frames.

17. Apparatus as claimed in claim 16, which is adapted to change the bit rate of a compressed input digital signal which includes intra-coded (I) picture frames, forward prediction (P) picture frames, bi-directional (B) picture frames and a transmitted quantisation parameter, the apparatus including means for inverse quantising the I, P and B frames, for re-quantising the I and P frames with the transmitted quantisation parameter and for re-quantising the B frames with a different quantisation parameter.

18. Apparatus as claimed in claim 16, which is adapted to change the bit rate of a compressed input digital signal which includes intra-coded (I) picture frames, forward prediction (P) picture frames , bi-directional (B) picture frames and a transmitted quantisation parameter, the apparatus including means for inverse quantising the I, P and B frames and for re-quantising the I, P and B frames with a quantisation parameter which is different from the transmitted quantisation parameter.

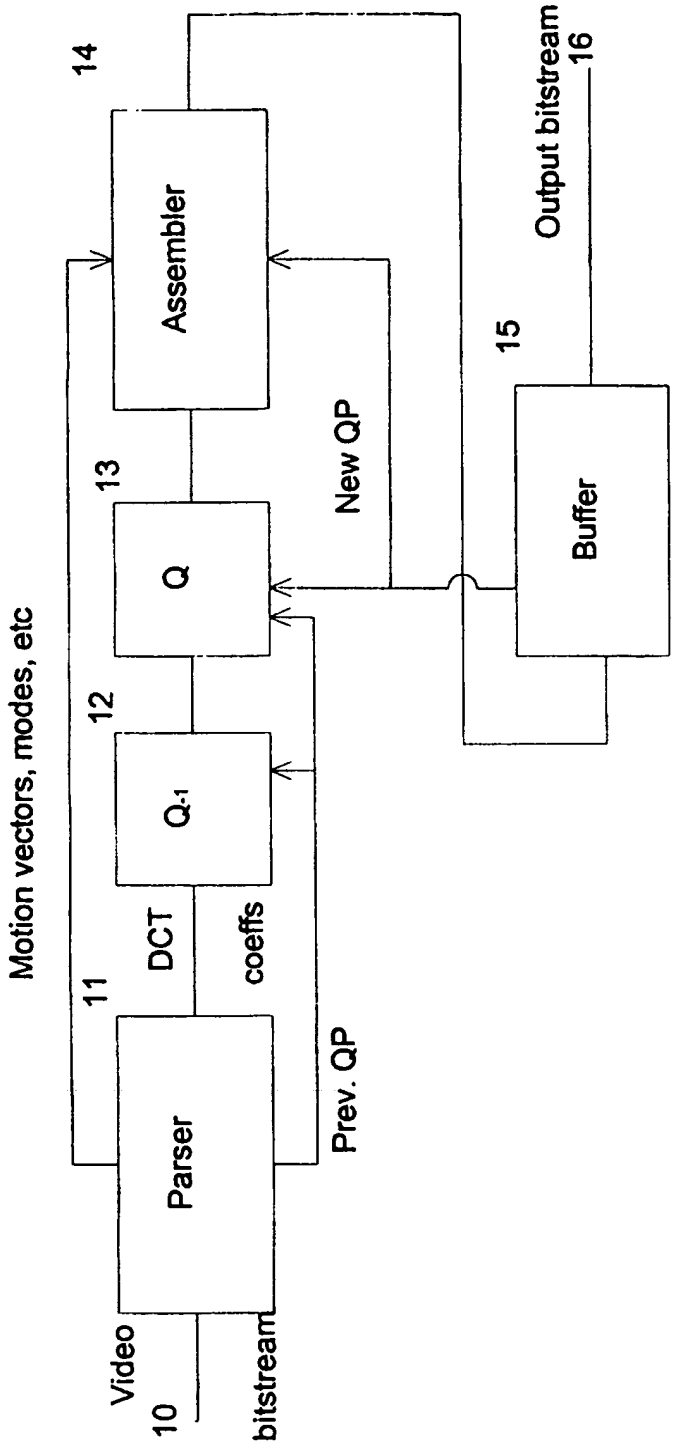

Video
10
bitstream
Parser
11
DCT
coeffs
Prev. QP
Motion vectors, modes, etc
Q^{-1}
12
Q
13
New QP
Assembler
14
Buffer
15
Output bitstream
16

FIGURE 1

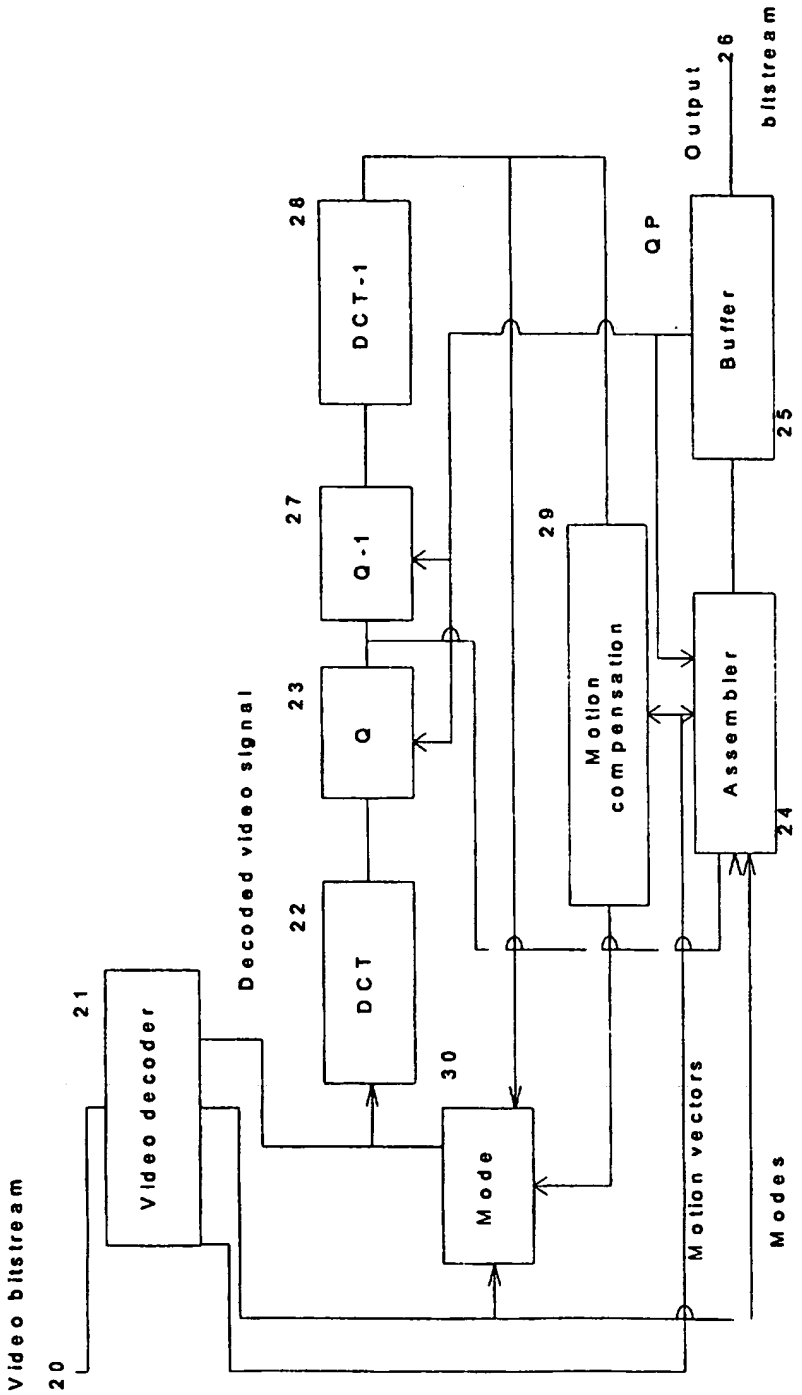

Video bitstream
20
Video decoder
21
Decoded video signal
DCT
22
Q
23
Q-1
27
DCT-1
28
Mode
30
Motion compensation
29
Assembler
24
Buffer
25
QP
Output bitstream
26
Motion vectors
Modes

FIGURE 2

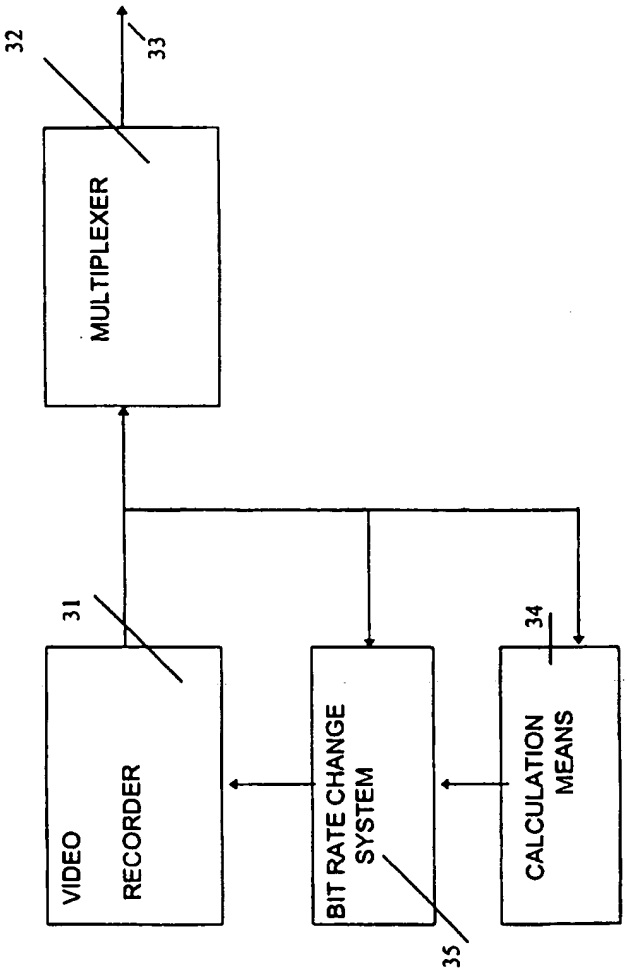

32
33
MULTIPLEXER
31
34
VIDEO RECORDER
BIT RATE CHANGE SYSTEM
CALCULATION MEANS
35

FIGURE 3